

THE EFFICIENCY OF PRECAUTIONS FOR PULMONARY FUNCTIONS TEST LABORATORIES DURING THE COVID-19 PANDEMIC: A REAL-LIFE SETTING

HÜLYA DIROL^{1 A-G}
• ORCID: 0000-0002-7712-6467

¹ Akdeniz University Hospital Chest Department, Antalya,
Turkey

HALID BAL^{1 A,B,D,E,G}
• ORCID: 0000-0003-2496-2100

OMER OZBUDAK^{1 A,E,F,G}
• ORCID: 0000-0001-9516-8129

A – study design, B – data collection, C – statistical analysis, D – interpretation of data, E – manuscript preparation, F – literature review, G – sourcing of funding

ABSTRACT

Background: Recommendations were developed for pulmonary function test (PFT) laboratories during the Coronavirus Disease 2019 (COVID-19) pandemic. However, it is unknown whether these recommendations are effective and safe.

Aim of the study: To assess how effective and safe the recommendations for PFT laboratories were during the COVID-19 pandemic.

Material and methods: This is a single-center, questionnaire-based study performed between June and August of 2020 at the Akdeniz University hospital. We performed the questionnaire over the phone with technicians from different centers in Turkey. We asked the age, gender, years on the job, routines performed during the pandemic, how many PFTs per day they performed, features of the test room, use of personnel protective equipment, whether they performed triage before the test, and the results of those who had a COVID polymerase chain reaction (PCR) test or a COVID antibody test.

Results: A total of 74 technicians from 69 centers were included in the study. Of the centers, 67 (90.5%) were located in tertiary hospitals. At the beginning of the pandemic, 65 (94.2%) centers closed for an average of 2.15 months. The average number of tests performed per day was 14.41±11.88. All centers triaged patients before performing the tests. In 19 (27.5%) centers, a transparent nylon separator was placed between the patient and the technician. Two (0.27%) technicians tested positive for COVID using PCR testing. Among the 12 (16.2%) technicians screened for COVID-19 antibodies, none of them were found to have COVID-19 antibodies.

Conclusion: The recommendations for PFT laboratories seemed to be effective and safe, and the adherence to these recommendations by the technicians was optimal.

KEYWORDS: COVID-19, pulmonary function test, technician, respiratory

BACKGROUND

Coronavirus Disease 2019 (COVID-19) is a disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), a virus from the Coro-

naviridae family. This virus is responsible for a pandemic and is a worldwide threat. Despite very strict precautions during the first 6 months of the pandemic, many people died from this disease. There was no other option but to protect oneself from this rapidly

spreading and deadly virus until an effective treatment could be found. For this reason, many new rules were required to prevent the spread of the virus.

Numerous precautions were instituted at hospitals during the normalization period of the COVID-19 pandemic as part of the return to normalization plan in hospitals. The recommendations for pulmonary function test (PFT) laboratories were created based on the fact that COVID-19 is transmitted from person to person via pulmonary secretions (1). However, these recommendations were developed based on experience gained from previous pulmonary infections, not COVID-19, and thus no one knows how effective and safe they are in real life.

Herein, a questionnaire-based study was conducted to evaluate how PFT laboratories adjusted and whether the precautions taken were safe for technicians during the COVID-19 pandemic in Turkey.

AIM OF THE STUDY

This study aimed to evaluate the effectiveness and safety of recommendations developed for PFT laboratories during the COVID-19 pandemic.

MATERIAL AND METHODS

Sample

This is a single center, cross sectional, observational study, conducted between June and August of 2020 at the Akdeniz University hospital in Turkey. A list of technicians working in the PFT laboratories was obtained and from the list, 100 out of the 389 technicians were randomly selected. We performed the questionnaire over the phone with each technician. The technicians that were able to be reached by phone voluntarily accepted to participate in the study. We developed the questionnaire using the guidelines on working in health institutions and infection control measures during the COVID-19 pandemic, developed by the Ministry of Health, the European Pulmonary Society (ERS), the American Thoracic Society (ATS), and the British Thoracic Society (BTS) (2-5).

Methods

A total of 389 technicians were currently working from the list provided by the Turkish respiratory technicians group. We aimed to perform the questionnaire on 100 of these technicians to provide 95% confidence levels, a standard deviation (SD) of 0.5, and a confidence interval of $\pm 8\%$. For these reasons, PFT laboratories (university hospitals and training and research

hospitals) located in 7 different regions of our country, primarily in the most populated cities, were searched. The accreditation of private hospitals and other small medical centers is not well known. Therefore, we only included technicians working in large, major centers. A total of 74 technicians participated in the study. We obtained data about age, gender, comorbidities, medications, years in the job, work routines during the pandemic, and how many patients per day performed PFTs. Regarding the PFT room, we collected data on the use of negative pressure, ultraviolet radiation, windows, carpets, and curtains. Regarding the order of work, we asked questions about whether they performed triage before the PFT, required an appointment, used personal protective equipment, and how many times they repeated the test in a patient. The results of those who received a COVID polymerase chain reaction (PCR) test or a COVID antibody test were also obtained over the phone.

Ethics

Approval for our study was granted by the Clinical Research Ethics Committee of Akdeniz University Faculty of Medicine (decision no: 457, dated: 23.06.2021). We also received approval from the Turkish Ministry of Health to perform the study.

Statistical analysis

The SPSS 21.0 package program (SPSS IBM Corp; Armonk, NY, USA) was used for the analysis. A p-value of < 0.05 was considered statistically significant. Descriptive statistics were presented using frequencies, percentages, means, SDs, medians, and minimum (min.) and maximum (max.) values. Fisher's Exact or Pearson chi-square tests were used to analyze the relationships between categorical variables. For the distribution of numerical measurements, the Kolmogorov Smirnov test was used. For the comparison of groups, a t-test, Mann Whitney U test, ANOVA, and Sidak's test were used.

RESULTS

Descriptive data

A total of 74 technicians from 69 centers were included in our study (Table 1). Of the centers, 67 (90.5%) were in tertiary hospitals. Of the technicians, 60 (81.1%) were female and the mean age was 42.38 ± 7.68 years old. The mean years of experience in their job was 8.48 ± 7.38 years. Twenty-six (35.1%) technicians had at least one comorbidity with the most

common ones being asthma and hypertension. During the first few months of the pandemic, 65 (94.2%) of the centers were closed for an average of 2.15 months. The average number of tests per day was 14.41 ± 11.88 for spirometry, 1.90 ± 3.22 for diffusion tests, and 4.59 ± 3.92 for the six minute walking test.

Table 1. Characteristics of the technicians, downtime, and number of the tests during the pandemic

Number of technician	74
Age(years) Mean \pm SD	42.38 \pm 7.68
Gender, n (%)	
Male	14 (18.9%)
Female	60 (81.1%)
Hospital	
Tertiary	67 (90.5%)
Non-tertiary	7 (9.5%)
The year in the job Mean \pm SD	8.48 \pm 7.38
Comorbidity n (%)	
Yes	26 (35.1%)
No	48 (65.9%)
Downtime Mean \pm SD	2.15 \pm 2.06
Number of PFT in a day Mean \pm SD	14.41 \pm 11.88
Number of Diffusion tests in a day Mean \pm SD	1.90 \pm 3.22
Number of 6MWTs in a day Mean \pm SD	4.59 \pm 3.92

SD – Standard Deviation; n – Number; PFT – Pulmonary Function Test; 6MWT – 6 Minute Walking Test.

Main outcomes

Regarding the testing rooms, none of the centers had negative pressure ventilation and 6 (8.7%) of them had no windows. None of the centers had carpet, while 15 (21.7%) of them had curtains in the test rooms. There was an ultraviolet light in 19 (27.5%) of the centers and one center had a HEPA filter/aspirator device in the test room. A transparent nylon separator was placed between patients and technicians in 19 (27.5%) of the centers (Table 2). Regarding the order of work, all centers were performing triage prior to the test. One center was performing COVID-19 PCR tests before conducting PFTs. Sixty-two (89.9%) centers required an appointment. All technicians wore surgical masks during testing, and 53 (71.6%) of them wore N95 masks under their surgical mask. The rates of not wearing glasses, bonnets, visors, and aprons as part of their personnel protective equipment were 56 (76.7%), 56 (76.7%), 35 (47.9%), and 30 (41.1%), respectively. The mouthpiece/filter used was disposable in all centers, as were the nose clips used in 38 (55%) centers. During the test, the distance between the patient and technician was less than 1 meter in 15 (21.7%) of the centers.

Table 2. Characteristics of the centers and the use of personnel protective equipment during pandemic

Total number of centers	N=69 (100%)	Total number of technician	N=74 (100%)
Triage before the test		Surgical mask n	
Yes	69 (100%)	Yes	74 (100%)
No	0	No	0
Appointment before the test		N95	
Yes	62 (89.9%)	Yes	53 (71.6%)
No	7 (10.1%)	No	21 (28.3%)
Shift work		Gloves	
Yes	32 (43.8%)	Yes	37 (50.0%)
No	41 (56.2%)	No	37 (50.0%)
Negative pressure room		Face shield	
Yes	0	Yes	38 (51.3%)
No	69 (100%)	No	36 (48.6%)
Ultraviolet		Glasses	
Yes	19 (25.7%)	Yes	18 (24.3%)
No	50 (74.3%)	No	56 (75.7%)
Window		Bones	
Yes	68 (96.6%)	Yes	18 (24.3%)
No	1 (3.4%)	No	56 (75.7%)
Carpet		Box	
Yes	0	Yes	44 (59.5%)
No	69 (100%)	No	30 (40.5%)
Curtain		Separator	
Yes	64 (92.8%)	Yes	19 (25.7%)
No	5 (7.2%)	No	45 (74.3%)
Printer		Distance	
Yes	33 (47.8%)	<1 meter	15 (20.3%)
No	36 (52.2%)	1–2 meters	57 (77%)
		>2 meters	2 (2.7%)

Table 2 contd.

Total number of centers	N=69 (100%)	Total number of technician	N=74 (100%)
Test attempts 2 times 3 times	64 (92.8%) 5 (7.2%)	Nose clip Disposable Re-use after sterilization Manual-closing	38 (51.4%) 4 (5.4%) 32 (43.2%)
Surface cleaning with 0.1–0.5 NaOCl or 62–71% C ₂ H ₆ O Yes No	69 (100%) 0	Mouthpiece Disposable Re-use after sterilization	69 (100%) 0

NaOCl – Sodium hypochlorite; C₂H₆O – Ethanol.

During the pandemic, 30 (40.5%) technicians were tested for COVID-19 using a PCR test and 2 (0.27%) of them were positive. The diagnosis was made while one technician was actively working in the test room, and the other technician was working in a different department while the testing room was closed. A COVID-19 antibody test was performed on 12 (16.2%) technicians for screening purposes but none of them were found to have COVID-19 antibodies (Table 3).

Table 3: Distribution of COVID-19 PCR and COVID-19 antibody test results

Total	N=74 (100%)
COVID-19 PCR	
Positive	2 (2.7%)
Negative	28 (37.8%)
Not examined	44 (59.5%)
COVID-19 antibody	
Positive	0 (0%)
Negative	12 (16.2%)
Not examined	62 (83.8%)

COVID PCR – Coronavirus Disease Polymerase Chain Reaction.

DISCUSSION

In this study, we investigated the working order and the precautions taken in PFT rooms and the risk and prevalence of COVID-19 among technicians during the pandemic in Turkey. We observed that the centers were generally well-adapted to the guidelines regarding pulmonary function laboratories. The technicians wore personnel protective equipment and followed the recommendations on using the equipment. The prevalence of COVID-19 was not higher than that of the general population. Our study revealed that the precautions taken in pulmonary laboratories were sufficient to prevent the transmission of COVID-19 among pulmonary technicians.

We have to deal with the pandemic by primarily avoiding the virus until the development of an effective antiviral drug. However, the suggestions to protect oneself from SARS-CoV-2 are based on the general features of the Coronaviridae family. Although

SARS-CoV-2 displays many characteristics similar to its origin, it can exert different behaviors. There are some reports on the function and organization of pulmonary function laboratories and the personal protection measures of the pulmonary technicians, developed by various associations and health ministries of the countries. Many of these reports suggest that PFTs are high aerosol-generating procedure. Based on this, a series of changes in pulmonary laboratories have been developed for the protection of both healthcare professionals and patients. However, it is unknown whether these measures are sufficient. Besides this, the debate over whether PFTs are aerosol-generating procedures or not is still ongoing. Therefore, there is an urgent need for evidence-based information on whether the protective precautions are sufficient.

Initially, some authors recommended that PFTs be performed in patients with chronic lung diseases requiring immediate treatment and in patients with hematological malignancies before and after hematopoietic stem cell transplantation. The ERS recommends dividing the pandemic into phases according to the prevalence in the population and developing recommendations based on safety levels at each phase. They also recommend restricting PFTs to patients requiring urgent/essential tests for the immediate diagnosis of a current illness during the pandemic phase which is characterized by a high community prevalence. We observed that the majority of PFT laboratories were closed for an average of two months during the pandemic period in Turkey. After the first few months, all PFT rooms started to reopen, operating under new precautions and significantly reducing the number of daily tests performed in PFT laboratories in Turkey.

Our study shows that the number of daily spirometry and diffusing capacity tests were reduced in PFT laboratories located in Turkey. No center performed body plethysmography as it was found to be inappropriate by our national guidelines. However, ERS recommends primarily spirometry and diffusing capacity tests for the evaluation of lung function but included whole body plethysmography in cases where droplet contamination control achievement in need-

ed (3). Moreover, ERS recommended cardiopulmonary exercise tests and broncho-provocation tests if they are necessary and if the patient does not have a risk of COVID-19. However, we observed that these tests were not performed in any center in Turkey during the pandemic.

Self-protection of technicians is a standardized procedure in our national report (2). Protective personal equipment (PPE) such as aprons, FFP2/ N95 masks, visors, and gloves should be worn during testing. Due to the risk of aerosolization, a maximum of 2 test runs per test is recommended. In our study, most technicians used N95 masks during testing but the use of bonnets and glasses were much less. All the technicians were performing one to two test runs per test. It is recommended to evaluate the possibility of COVID-19 before the test in reports. We observed that triaging was applied to all patients before tests in all 69 centers, and moreover, COVID-19 PCR testing was performed before tests in two centers.

There are reports that also provide recommendations for equipment. High specification disposable bacterial and viral filters and disposable nose clips should be used during spirometry. If there is a negative pressure room, it is recommended to perform the tests in these rooms. But, there are no official recommendations by the center of disease control regarding the use of portable HEPA cleaners for the decontamination of airborne SARS-CoV-2 (6). In our study, we observed that in general, centers obeyed the recommendations regarding equipment and room design. Moreover, we determined that a transparent nylon separator was placed between patients and technicians in four centers. We do not know whether this is effective or not. Its efficacy and safety still need to be investigated. However, if it is scientifically proven to be effective, it can be a good solution especially for

low-income countries as it is practical and inexpensive.

The ultimate goal of all these regulations is to protect technicians and patients from COVID-19. Our study observed that the prevalence of COVID-19 in technicians working in PFT laboratories was not higher than that in the general population. Only two technicians were PCR positive and none of them had antibodies against SARS-CoV-2. In summary, all precautions being implemented in pulmonary testing rooms are sufficient to protect technicians from COVID-19.

Limitations

There are some limitations of our study. It is a questionnaire-based study and the results are based on the technician's statements. Most technicians worked in tertiary hospitals. We randomly phoned technicians in different regions of Turkey with different disease prevalence rates.

CONCLUSION

To our knowledge, this is the first study comprehensively examining this issue in Turkey, and despite the single-center design, a significant number of technicians were screened. In conclusion, the organization of pulmonary test rooms in Turkey are effective and safe. The prevalence of COVID-19 in technicians working in PFT laboratories is not higher than the general population. The lower prevalence may be related to the well-done determination of pre-test indications, pre-test COVID-19 risk assessments, adherence to precautions about room arrangement, and effective use of personnel protective equipment.

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Correspondence address:

Hülya Dirol

Dumlupınar Boulevard Akdeniz University Hospital 07059

Campus, Antalya, Turkey

E-mail: hulyadirol@akdeniz.edu.tr

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